

## A new species of tree frog (Anura, Hylidae, *Litoria*) from the mountains of Irian Jaya, Indonesia

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**A new species of hylid frog is described from lower montane rainforest (1070 m elevation) in the headwaters of the Wapoga River, Irian Jaya. The new species shows affinities to some members of the *Litoria nigropunctata* species-group but can be distinguished from all described species in that group by a combination of dark brown colouration on the hidden surfaces of the thighs, groin and axilla, and dorsal colouration which consists (in life) of small yellow spots on a uniform green background. The advertisement call is a short, distinctly pulsed note lasting about 0.2 second, with a dominant frequency of about 2.5 kHz.**

### INTRODUCTION

The Australopapuan hylid frog genus *Litoria* reaches its greatest diversity in Australia and mainland New Guinea (FROST, 1985). Although the genus is relatively well documented in Australia (BARKLER et al., 1995), the New Guinea fauna remains poorly known. This is particularly true for the Indonesian province of Irian Jaya where fauna surveys have lagged behind those in neighbouring Papua New Guinea (ALLISON & DWYAHRENI, 1997).

Ten small green *Litoria* species have been reported from the mountains of New Guinea. MINZIES (1993) included six of these (*Litoria chloronota*, *L. iris*, *L. havana*, *L. leucova*, *L. mucro* and *L. ollauri*) in the *Litoria nigropunctata* species-group, which was defined (in part) by TYLER & DAVIES (1978) as "small to medium species with short, 1/3-webbed fingers and almost fully webbed toes. Predominantly green in life and may be marked with gold and black". JOHNSTON & RICHARDS (1994) subsequently redefined *L. leucova* and suggested that it may be related to torrent-dwelling frogs of the *L. becki* species-group of TYLER & DAVIES (1978). They described an additional member of the *L. nigropunctata* group, *Litoria majkithae*, from the foothills of the Star Mountains.

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*Litoria contrastens* is a montane representative of the predominantly lowland *Litoria bicolor* species-group, and two other small green *Litoria*, *L. bulmeri* and *L. longicrus*, are torrent-dwelling frogs that live along steep mountain streams (S. J. Richards, personal observations). TYLER & DAVIES (1978) placed *L. bulmeri* in a monotypic species group and, based solely on morphological characters, erroneously included *L. longicrus* in the *L. bicolor* species group. Two of these species have been reported from Irian Jaya. *Litoria iris* is widespread along the central mountainous spine of New Guinea, reaching its western limit in the Star Mountains in Irian Jaya (TYLER, 1968). *Litoria chloronota* is endemic to Irian Jaya, being known only from the Arfak Mountains on the Vogelkop Peninsula (TYLER, 1968; MENZIES, 1993).

During a biodiversity survey in the mountainous headwaters region of the Wapoga River, Irian Jaya (MACK & ALONSO, 2000), we collected eight specimens of an undescribed, small green treefrog showing some affinities with the *Litoria nigropunctata* species-group (TYLER & DAVIES, 1978). Here we describe the new species and provide information on its advertisement call and natural history.

#### MATERIAL AND METHODS

Specimens are deposited in the Museum Zoologie Bogoriense (MZB), Indonesia, and the South Australian Museum (SAMA), Australia. Additional specimens examined for comparisons (see list in app. 1) are in the British Museum (BM) and the Natural Sciences collection of the University of Papua New Guinea (UP). Measurements (to the nearest 0.1 mm) were taken with dial callipers and a stereomicroscope fitted with an ocular micrometer, and follow MENZIES (1993). They are SVL (snout-vent length), TL (tibia length), HW (head width at tympanum), HL (head length from tip of snout to posterior edge of tympanum), EYE (horizontal eye diameter), TYM (horizontal tympanum diameter), IN (inter-narial distance), EN (distance between anterior edge of eye and posterior edge of naris), 3FD (horizontal diameter of 3<sup>rd</sup> finger disc) and 3FP (narrowest horizontal width of 3<sup>rd</sup> finger penultimate phalanx), 4TD and 4TP (4<sup>th</sup> toe disc and penultimate phalanx, as for 3<sup>rd</sup> finger). For measurements and proportions, the mean ( $\bar{x}$ ) is given below followed by the standard deviation ( $s$ ) and the range.

Calls were recorded with a Sony Professional Walkman tape recorder and SMZ-200 microphone, and were analysed with the sound analysis program Avisoft SAS-Lab Pro.

#### RESULTS

##### *Litoria wapogaensis* sp. nov. (fig. 1-6)

*Holotype* MZB Amp 3873, adult male, collected at Wapoga Alpha exploration camp (136°34.423'E, 3°08'687"S, 1070 m elevation) in the headwaters of the Wapoga River, Irian Jaya Province, Indonesia, on 12 April 1998, by S. Richards & D. Iskandar.

*Paratypes.* - MZB Amp.3874-3875, SAMA R54595-54598, adult males collected at the same locality as the holotype on 9 April 1998; MZB Amp.3876, adult male collected at the same locality as the holotype on 15 April 1998

*Diagnosis.* - A small *Litoria* (males 30.5-32.9 mm SVL) characterised by: (1) snout broadly rounded in dorsal view and bluntly rounded in lateral view, (2) canthus rostralis poorly defined, gently rounded and straight or slightly curved; (3) vomerine teeth present; (4) fingers one half webbed; (5) dorsum (in life) green with small yellow spots; (6) axilla, groin and hidden surfaces of thighs deep purplish brown; and (7) advertisement call a single, distinctly pulsed note.

*Description of holotype.* - Head moderately slender (HW/SVL 0.35), head about as wide as long (HL/HW 1.02), slightly more than one-third body length (HL/SVL 0.35). Snout broadly rounded in dorsal view, bluntly rounded in lateral view (fig. 1, 3). Dorsal one-fifth of tympanum obscured by gently curving supratympanic fold that extends from posterior edge of eye half-way to point of arm insertion. Eye relatively large, prominent (EYE/SV 0.123). Canthus rostralis poorly defined, gently rounded, slightly curved, loreal region slightly concave. Vomerine teeth in two raised patches between choanae, vocal slits present. Tongue broadly cordiform.

Limbs slender. Fingers short, outer fingers one-half webbed; relative lengths of fingers III > IV > II > I, terminal discs large, prominent (3FP/3FD 0.64). Subarticular tubercles distinctly bi-lobed. Brown nuptial pad on each thumb. Legs moderately long (TL/SVL 0.59). Toes nearly fully webbed, web reaching base of disc except on 4<sup>th</sup> toe where webbing reaches penultimate tubercle and continues as fringe along toe to base of disc. Toe discs large, prominent (4FP/4FD 0.69). Relative lengths of toes IV > III = V > II > I. Subarticular tubercles on toes 3-5 bi-lobed.

Dorsum very finely striated (nearly smooth), without tubercles on head or body. Ventral surface finely granular on throat, coarsely granular on belly. Large white tubercles on ventral surface of thighs.

*Colour in life.* - Dorsally uniform green with scattered, small yellow spots, narrow, pale yellow stripe around upper jaw. Ventral surfaces white. Axilla, groin and posterior of thigh deep purplish brown.

*Colour in preservative.* - Dorsally pale blue with small white spots, a faint white stripe around upper jaw. Pigmentation in axilla, groin and posterior of thigh dark brown. Brown pigment on legs sharply delineated from blue dorsal colouration of limbs by two narrow strips of black and brown pigmentation. Blue pigmentation on arms terminating abruptly in clearly demarcated line at wrist. Pigment on hands restricted to fine brown stippling on dorsal surfaces of 3<sup>rd</sup> and 4<sup>th</sup> fingers, extremely sparse on 2<sup>nd</sup> finger. Plantar surfaces with scattered brown pigmentation.

*Measurements (mm) of holotype.* - SVL 30.7; TL 18.2; HW 10.6; EYE 3.8; EN 3.0; IN 3.8; TYM 1.6; 3FD 1.7; 3FP 1.1; 4FD 1.6; 4FP 1.1.

*Variation.* - There are seven paratypes, all adult males (SVL 30.5-32.9 mm). Dorsal colouration of all specimens is pale to dark blue (green in life) with scattered small white (yellow in life) spots. In some specimens a few spots are very pale blue (pale, yellowish green in life).

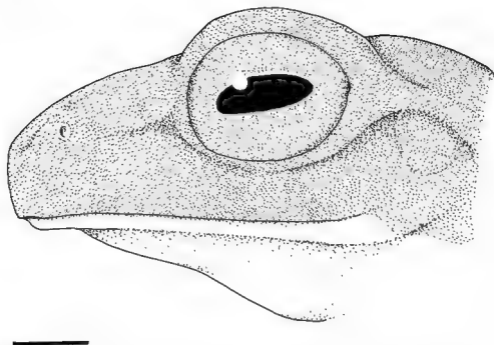


Fig. 1. Lateral view of the head of *Litoria wapogaensis*, paratype (SAMA R54595) Scale bar = 2 mm

and several specimens have very small, intensely dark blue (dark green in life) spots concentrated laterally. The dark brown colouration of the concealed surfaces of the thighs and axilla is a conspicuous feature of all specimens and is retained in preservative. All paratypes have a prominent short, raised white ridge below the vent, a feature that is poorly developed in the holotype. In two of the paratypes (SAMA R54596 and 54598), the vomerine teeth are poorly developed.

*Measurements (mm) and proportions of the six paratypes:  $\bar{x} \pm s$  range.* SVL 31.85  $\pm$  0.91, 30.5-32.9; TL 18.1  $\pm$  0.51, 17.4-19.0; HW 10.97  $\pm$  0.25, 10.5-11.1; EYE 3.81  $\pm$  0.21, 3.5-4.1; EN 2.95  $\pm$  0.17, 2.7-3.2; IN 3.81  $\pm$  0.16, 3.6-4.0; TYM 1.53  $\pm$  0.05, 1.5-1.6; 3FP 1.05  $\pm$  0.12, 0.9-1.3; 3FD 1.71  $\pm$  0.21, 1.4-2.0; 4TP 1.0  $\pm$  0.15, 0.8-1.2; 4TD 1.52  $\pm$  0.18, 1.3-1.7; TL/SVL 0.56  $\pm$  0.02, 0.53-0.59; EYE/SVL 0.12  $\pm$  0.008, 0.1-0.13; EN/IN 0.77  $\pm$  0.05, 0.71-0.88; 3FP/3FD 0.62  $\pm$  0.06, 0.55-0.71; 4P/4FD 0.65  $\pm$  0.06, 0.58-0.75

*Advertisement calls.* We recorded 28 calls from three specimens. Two different calls were produced. The most frequently produced call (78.6% of total), and the one that we presume to be the advertisement call, was a single distinctly pulsed note emitted at irregular intervals (fig. 5; tab. 1). The mean length of 22 calls was 0.20 s ( $s = 0.03$ , range 0.16-0.30). Mean pulse rate was 41.39/s (40.7, 34.0-47.8) and the mean dominant frequency was 2357 Hz (2177, 1733-2659). The second call type was emitted infrequently, and was possibly produced during

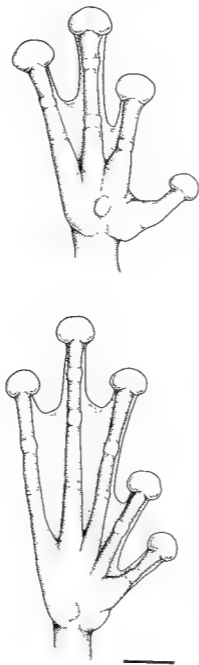


Fig 2 Palmar and plantar views of the hand and foot of *Litoria wapogaensis*, paratype (SAMA R54595) Scale bar: 2 mm



Fig. 3. – *Litoria wapogaensis* male in calling position, Wapoga, Irian Jaya

inter-male interactions, although further observations are required to confirm this. These calls were shorter (mean length 0.15 s), and had a much higher pulse rate (mean 235.97/s, fig. 5). Detailed analyses are presented in tab. 1.

*Natural history* The collection locality is in closed-canopy lower-montane rainforest. One specimen was collected at night from a *Pandanus* leaf at a height of about 1.0 m in a small *Pandanus* swamp. The remaining specimens were calling at night from fern fronds and other low vegetation along a slow-flowing, shallow and swampy stream (fig. 4). These were the only lentic waterbodies in the area. Despite the abundance of swiftly flowing streams in the region, this species was never collected or observed in lotic habitats.

*Comparison with other species* In its general size, dorsal colouration and extent of finger webbing, *Litoria wapogaensis* shows some affinities with *L. iris* and its allies (as defined by MENZIES, 1993) within the *L. nigropunctata* species-group. A comparison of morphological characters among montane green *Litoria* is presented in tab. 2. Most species can be readily distinguished in life on the basis of thigh colouration. The concealed surfaces of the thighs are brightly coloured (purple, orange, red or blue) in *Litoria chloronota*, *L. iris*, *L. mapkthuse* and *L. ollauru* (versus dark brown in *L. wapogaensis*). The latter three species also differ in possessing a violet patch in the groin and axilla (versus dark brown). *Litoria havina* has bright red thighs, and males are further distinguished from *L. wapogaensis* by the presence of a rostral spike (absent in *L. wapogaensis*). *Litoria wapogaensis* can also be distinguished from all of these species by its advertisement call, which is a single distinctly pulsed note. MENZIES

Table 1. - Advertisement call characteristics of *Litoria wapogaensis* sp. nov. Measurements are given as mean (standard deviation) range. See text for description of call types.

Specimen Call Type	SAMA R54595		SAMA R54596		MZB Amp 3876	
	slow	fast	slow	fast	slow	Fast
Air temperature (°C)	22.6		22.6		20.4	
n	5	1	5	1	12	4
Length (s)	0.182 (0.019) 0.16-0.20	0.359	0.224 (0.047) 0.176-0.301	0.095	0.214 (0.027) 0.16-0.252	0.115 (0.071), 0.07-0.22
Pulses	8-10	50	8-12	32	7-12	21-36
Pulse rate (pulses/s)	41.71 (1.89) 38.46-43.06	136.5	35.59 (0.9) 34.09-36.54	326.3	43.67 (3.0) 37.5-47.82	238.26 (58.56) 157.6-285.7
Dominant frequency (Hz)	2400 (141.83) 2204-2573	2834	2354 (35.68) 2315-2404	2326	2341 (285) 1733-2659	2142.3 (445) 1707-2708

(1993) and JOHNSTON & RICHARDS (1994) provided detailed descriptions of the calls of *L. iris* and other members of this group.

*Litoria contrastens* (male SVL 25-30 mm) is smaller than *L. wapogaensis* (male SVL 30.5-33 mm), with an immaculate dorsum (versus yellow-spotted), relatively shorter legs, a relatively longer snout, and without vomerine teeth (tab. 2). The shape of the snout (distinctly projecting in profile) is also quite different from *L. wapogaensis* (bluntly rounded in profile). *Litoria bulmeri* is a torrent-dwelling species (S. J. Richards, unpublished) that is readily distinguished from *L. wapogaensis* by having fingers free of webbing and a broad black lateral band, and is not considered further here. *Litoria longicrus* is a small species (SVL < 30 mm) with a broad white bar beneath the eye and has much longer legs than *L. wapogaensis* (TL/SVL 0.62-0.63 versus 0.53-0.59).

Four lowland species that are partly or entirely green in life are compared with *L. wapogaensis*. *Litoria nystax* is a small species (29.5 mm SVL) known only from the holotype. It can be distinguished from *L. wapogaensis* by its prominent and strongly curved canthus rostralis (versus poorly defined, slightly curved or straight), a broad white bar beneath the eye (absent in *L. wapogaensis*) and yellowish brown (versus white) venter (GYLER, 1968). *Litoria gracilentia* was described from northeastern Australia and the status of New Guinea populations is unclear (GUNTHER & RICHARDS, 2000). New Guinea specimens currently referred to *L. gracilentia*, and the recently described *Litoria elkeae*, are small green frogs (male SVL approximately 30 mm) in which the dorsum is frequently spotted with white, and there is a pale cantho-rostral stripe. The concealed surfaces of the thighs are cream or pale yellow in *L. elkeae* (versus dark brown in *L. wapogaensis*) (GUNTHER & RICHARDS, 2000).

*Litoria nigropunctata* is a small lowland frog that is predominantly brown or green-brown in life, and frequently exhibits small black spots on the dorsum. It further differs from

Table 2. - Comparisons among *Litoria wapogaensis* sp. nov. and small green *Litoria* occurring in the mountains of New Guinea (excluding *L. bulmeri* see text)

Species	SVL (mm) (males only)	Thigh colour	Violet in groin and axilla	TL/SVL	EN/IN	Advertisement call	Rostral spike (males only)	Vomerine teeth	Reference
<i>Litoria wapogaensis</i> sp. nov.	30.5-33	Dark brown	-	0.53-0.59	0.71-0.88	Single pulsed note	-	+	This study
<i>Litoria chloranota</i> (Boulenger, 1911)	27-32	Orange	-	0.52-0.58	0.63-0.71	Series of short and long notes	-	-	MENZIES, 1993
<i>Litoria contrastans</i> (Tyler, 1968)	25-30	Orange-red	-	0.45-0.54	0.89-1.17	Chicks followed by two-part buzz	-	-	TYLER, 1968, MENZIES, 1976
<i>Litoria havina</i> Menzies, 1993	30-36.5	Cherry red	-	0.54-0.6.	0.63-0.79	Series of whistles	+	-	MENZIES, 1993
<i>Litoria iris</i> (Tyler, 1962)	24-36	Purple, red or blue	+	0.46-0.63	0.77-0.97	Series of chicks and buzzes	-	+/-	MENZIES, 1993
<i>Litoria leucova</i> (Tyler, 1968)	30.5-35.4	Translucent pink with yellow spots	-	0.53-0.55	0.78-0.96	Short and long calls in long series	-	-	JOHNSTON & RICHARDS, 1994
<i>Litoria longicus</i> (Boulenger, 1911)	27.4	Unpigmented	-	0.623-0.628	0.58-0.61	?	-	+	TYLER, 1968
<i>Litoria majikahse</i> Johnston & Richards, 1994	30.5-34.4	Crimson	+	0.43-0.60	0.72-1.03	Short chirp or harsh "raugh"	-	+	JOHNSTON & RICHARDS, 1994
<i>Litoria macro</i> Menzies, 1993	< 31 mm	Golden-yellow peppered black	-	0.51-0.56	0.8-1.1	?	+	-	MENZIES, 1993
<i>Litoria olivacea</i> Menzies, 1993	< 34 mm	Blue	+	0.54-0.59	0.75-0.95	Quiet creaking noise	-	+	MENZIES, 1993





Fig 4 Habitat of *Litoria wapogaensis* in lower montane rainforest Wapoga River headwaters, Irian Jaya.

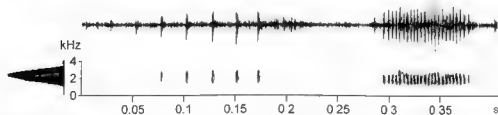


Fig 5 Wave form (top) and spectrogram and frequency spectrum (bottom) of two types of vocalisations of *Litoria wapogaensis*. Left, slow call; right, fast call.  $T_a = 22.6^\circ\text{C}$ .

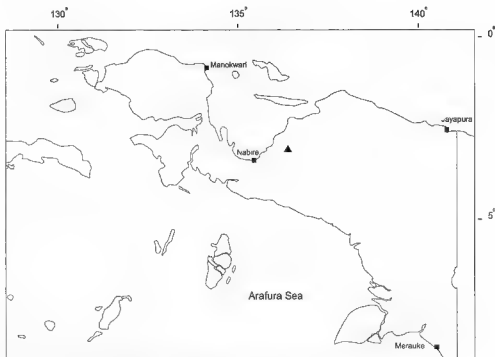


Fig. 6 Type (and only known) locality of *Litoria wapogaensis*, Irian Jaya, Indonesia

*L. wapogaensis* in having yellow (erroneously reported as black by JOHNSTON & RICHARDS, 1994) in the concealed parts of the thighs, in having a truncate (versus rounded) snout, and in its different advertisement call, which is an "irregular succession of clicks and buzzes" (MENZIES, 1972). Through the courtesy of Mr. David Price, we have examined several specimens and advertisement calls of *Litoria nigropunctata* from the vicinity of the type locality (Yapen Island, Irian Jaya). Morphologically and acoustically these animals agree closely with populations from mainland New Guinea (MENZIES, 1972; S. J. Richards, unpublished) and differ consistently from *L. wapogaensis* in the characters described above.

**Etymology** – Named for the headwaters of the Wapoga River, the major drainage system for the spectacular rainforest-clad mountains where the new species was collected

#### APPENDIX I ADDITIONAL SPECIMENS EXAMINED

*Litoria olkeae* Gunther & Richards, 2000 INDONESIA Irian Jaya Province, Siewa paratypes MZB Amp.3866-9

*Litoria husina* Menzies, 1993 PAPUA NEW GUINEA Western Province, Ok Ma paratypes UP 8406-7.

- Litoria iris* (Tyler, 1962) PAPUA NEW GUINEA Southern Highlands Province, Tari, UP3115-35, Eastern Highlands Province, Ubagubi, UP8289-90; Enga Province, Porgera, UP7148-67, Sandaun Province, Teleformin, SAMA R5423, 5874
- Litoria leucova* (Tyler, 1968) PAPUA NEW GUINEA Sandaun Province, Mount Stolle: SAMA R44091-44092, UP 8604-6.
- Litoria longicrus* (Boulenger, 1911) - INDONESIA Irian Jaya Province, Wondessi syntype BM 1947 2.22.61
- Litoria mapkithse* Johnston & Richards, 1994 PAPUA NEW GUINEA Western Province, all in general vicinity of Tabubil: holotype SAMA R44093, paratypes UP 6734, UP 7305-9, UP 8501-8, UP 8602-3, SAMA R44094-44101.
- Litoria nuro* Menzies, 1993 PAPUA NEW GUINEA East Sepik Province, near Raut Village paratypes UP 2741-2743, UP 2745-2756.
- Litoria nigropunctata* (Meyer, 1875) PAPUA NEW GUINEA Morobe Province, Lae, SAMA R09296, Madang Province, Binek near Madang, SAMA R11794.

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